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Gas Density Measurement Frequency
(Orifice Meters)

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INTRODUCTION

Note that this guide refers to gas measurement by orifice meters and is not applicable to measurement by positive displacement, turbine meters or vortex shedding meters.

The Oil and Gas Conservation Regulations in section 14.070 (8.1) requires the determination of gas density factors for use in computing gas production from a well or group of wells as measured by orifice meter. Frequent updates of these factors are necessary to preserve the accuracy of gas production volumes reported to the Board. This guide outlines in detail the gas density measurement frequency requirements for a number of different categories of gas production. The frequency of density measurement is based on the type of production (e.g. dry sweet gas, gas cycling scheme, single well oil battery) as it relates both to the potential for the gas density to change over time and the end use of the gas.

Recognition has been given to low-productivity gas production by specifying extended frequencies in some cases. Opportunities also exist for permanent exemption from the requirement to update gas densities where there is a history of stable densities.

Density measurement frequencies for all production categories are specified in Schedule 1 following this section. Typical production facility and gas measurement configurations consistent with Schedule 1 are shown in Figures 1 through 7, as are additional details and explanations. The Board considers these frequencies as the minimum requirement for gas density measurements. It is required that operators use the updated densities when calculating gas volumes reported to the Board. The ERCB also expects that a prudent operator would take the initiative to update the gas density where operating conditions are significantly altered (eg. addition/removal of compression or line-heating, addition/removal of production sources in a common stream, wellbore recompletion) or where measurement discrepancies exist.

The Board believes that the production groupings outlined in this guide provide adequate coverage for the scenarios encountered by operators. It is expected that operators will choose the category best suited to their production type. This selection process should ensure that a reasonable level of confidence in the accuracy of the gas density is maintained at all times. The Board recognizes, however, that there may still be situations where the frequencies specified are not appropriate. Examples could include pools in the advanced stages of depletion or well-established historical data trends. In such cases the Board would consider requests for frequencies outside those prescribed in this guide having regard for the engineering, equity, and royalty needs for measurement accuracy.

In addition to section 14.070(8.1), operators should be aware that two other related requirements exist. ERCB Informational Letter IL 87-1 recommends that gas compressibility factors (supercompressibility) used in orifice meter calculations be determined through full compositional analysis. In addition, section 11.080 of the Oil and Gas Conservation Regulations requires operators of field processing plants to obtain analyses for fluids entering and leaving the plant. Further, ERCB staff have observed that analyses of gas streams are often taken for a variety of purposes (e.g. joint venture and allocation agreements), at frequencies greater than those required by this guide. However, it is also observed that these analyses are often not used for the purpose of updating the density for orifice meter calculations. Opportunities may therefore exist to satisfy a number of requirements, both internal and ERCB, through the use of a single analysis. Operators are encouraged to investigate existing sources of analyses and density measurements before conducting additional sampling or analyses to comply with the revised section 14.070 (8.1). Gas densities for the purpose of complying with this regulation may be determined through direct gravitometer or densitometer measurements, or through full compositional analysis of the gas stream.

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Schedule 1 – Gas Density Measurement Frequency

Type of Production System			Gas Volume Measured	Frequency of Density Measurement	Density Measurement Points
1. Gas Well	S.E. Alberta Shallow Gas (Med. Hat, Milk River & Second White Specks Formations)			2 Years (1)	Each Meter Point (ie. Group Meter, Control Wells) (see figure 1)
	No Condensate or Oil			2 Years (1)	Per Well Meter (see figure 2) (2)
	Condensate or Oil		High	1 Year	Per Well Meter (see figure 3) (2)
			(3) Low	2 Years	
	Gas Storage Schemes/ Gas Cycling Schemes (After Breakthrough)			6 Months	Per Prod'n Well Meter (see figure 4)
2. Oil Well (5)	Single Well Battery		Flared	Initial (4)	Per Well Meter (see figure 5)
			Conserved	as for "Proration Battery"	
	Proration Battery	Primary Prod/ Water Flood	High	1 Year	Per Test Meter Per Pool, & Per Group Meter (see figure 6)
			(3) Low	2 Years	
		Miscible Flood (After Breakthrough)		6 Months	Per Test Meter Per Well, & Per Group Meter (see figure 6)
3. Crude Bitumen	Single Well Battery			Initial (4)	Per Well Meter (see figure 5)
	Multi–Well Facility			2 Years	Per Accounting Meter (see figure 6) (6)
4. Gas Facilities and Processing Plants				1 Year	Per Accounting Meter (see figure 7)

NOTES TO SCHEDULE 1

1. Exemption from the requirement to determine and update gas densities is available where densities have been shown to be consistent with depletion. Such exemption is considered appropriate where three consecutive density determinations, at the specified determination frequency or alternatively no more frequent than 1-year intervals, are shown to be within ± 1 per cent of the average of the three densities. The use of existing historical data is acceptable for this purpose. In this situation the operator is automatically relieved from the requirement of future density determinations **without application to the Board**. Records and data in support of this exemption must be retained by the operator and made available to a Board representative upon request. Notwithstanding this exemption, it is the expectation of the Board that a prudent operator will take the initiative to update gas densities where operating conditions are significantly altered or where measurement discrepancies exist.

2. An average density for all wells producing to a common gathering system or facility **from a common pool** can be used where the density of all common-pool wells are within 2 per cent of the average density of those wells. Gas densities must initially be obtained for all the common-pool wells to arrive at the average density. Subsequent density measurements can be made on 25 per cent or at least four wells from the pool (whichever is greater) at the frequency stated in the guide, provided the relative density variance remains within the 2 per cent limit of these wells. Should the variance exceed this limit, well densities must be determined for each measurement point.

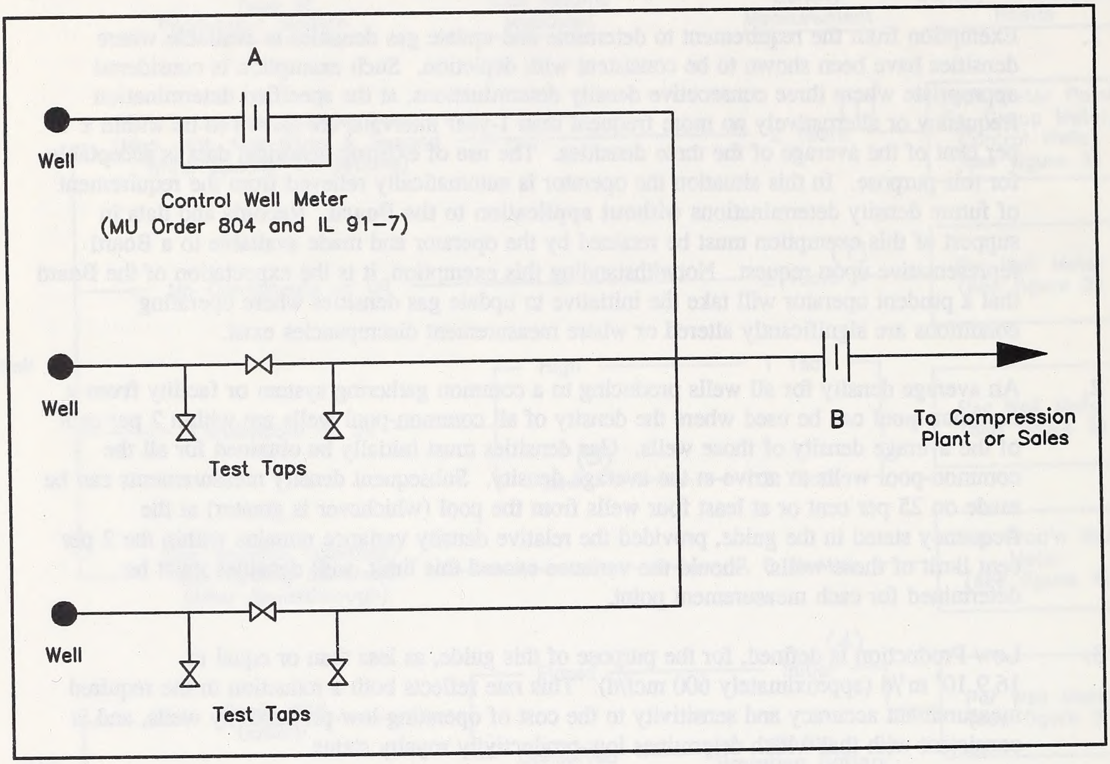
3. Low Production is defined, for the purpose of this guide, as less than or equal to 16.9 10^3 m^3/d (approximately 600 mcf/d). This rate reflects both a reduction in the required measurement accuracy and sensitivity to the cost of operating low-productivity wells, and is consistent with that which determines low-productivity royalty status.

4. An initial representative gas density determination is required within the first 6-months of production, after which no subsequent updates are required.

5. Crude oil wells which qualify for Gas Measurement Exemption (see ERCB Informational Letter IL 91-9) are not required to update the gas density after the initial density determination.

6. Consistent with the Alberta Recommended Practises (Volume 3) for Heavy Oil and Oil Sands Operations, gas produced in association with crude bitumen may be reported to the collection or emission point. Where associated gas is flowlined to a central facility or collection point, gas volumes can be reported on a facility basis without allocation back to the well level. The requirement to update gas densities therefore pertains only to the facility group or accounting meter, with no requirement for well-level density determinations.

Figure 1 — Southeastern Alberta Shallow Gas Proration Battery



Note: Other configurations may apply

In this configuration, densities are to be updated every 2 years at each control well meter (Meter A) and each group meter station (Meter B).

Notes

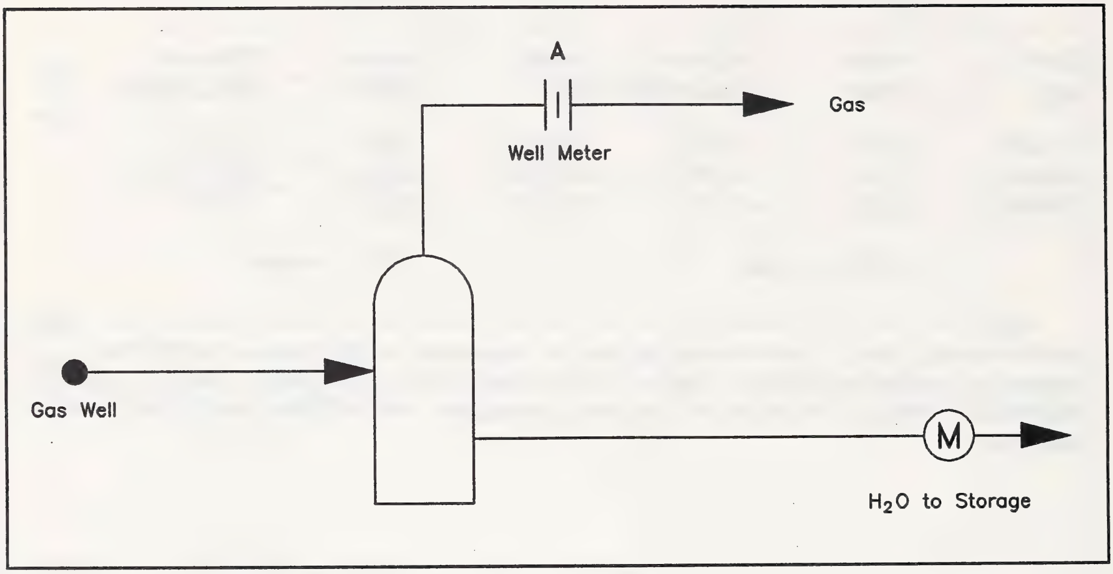
1. Exemption from the requirement to determine and update gas densities is available where densities have been shown to be consistent with depletion. Such exemption is considered appropriate where three consecutive density determinations, at the specified 2-year frequency or alternatively no more frequent than 1-year intervals, are shown to be within ± 1 per cent of the average of the three densities (see Example 1). The use of existing historical data is acceptable for this purpose. In this situation the operator is automatically relieved from the requirement of future density determinations without application to the Board. Records and data in support of this exemption must be retained by the operator and made available to a Board representative upon request. Notwithstanding this exemption, it is the expectation of the Board that a prudent operator will take the initiative to update gas densities where operating conditions are significantly altered or where measurement discrepancies exist.

EXAMPLE 1:

Meter A			Meter B		
Density Date	Relative Density	Difference from Average	Density Date	Relative Density	Difference From Average
01-06-92	0.583	-0.29%	01-06-92	0.580	+1.10%
05-06-93	0.586	+0.23%	05-06-93	0.569	-0.21%
01-06-95	0.585	+0.06%	01-06-95	0.572	-0.29%
	0.5847 (Average)			0.5737 (Average)	

In this example, Meter A would be exempt from the requirement for future updates as the three consecutive densities are within ± 1 per cent of the average of the three densities. Meter B would not be exempt, but could be in the future if the next or subsequent series of updates resulted in the criteria being met.

Figure 2 — Dry Gas Well Installation (no oil or condensate)



Note: Other configurations may apply

For this configuration, gas densities are to be updated every 2 years at each well meter (Meter A).

Notes

1. Exemption from the requirement to determine and update gas densities is available where densities have been shown to be consistent with depletion. Such exemption is considered appropriate where three consecutive density determinations, at the specified 2-year frequency or alternatively no more frequent than 1-year intervals, are shown to be within ± 1 per cent of the average of the three densities (see Example 2.1). The use of existing historical data is acceptable for this purpose. In this situation the operator is automatically relieved from the requirement of future density determinations **without application to the Board**. Records and data in support of this exemption be retained by the operator and made available to a Board representative upon request. Notwithstanding this exemption, it is the expectation of the Board that a prudent operator will take the initiative to update gas densities where operating conditions are significantly altered or where measurement discrepancies exist.

2. An average density for all wells producing to a common gathering system or facility **from a common pool** can be used where the density of all common-pool wells are within 2 per cent of the average density of those wells. Gas densities must initially be obtained for all the common-pool wells to arrive at the average density. Subsequent density measurements can be made on 25 per cent or at least four wells from the pool (whichever is greater) at the frequency stated in the guide, provided the relative density variance remains within the 2 per cent limit of these wells (see Example 2.2). Should the variance exceed this limit, well densities must be determined for each measurement point.

EXAMPLE 2.1:

Density Date	Relative Density	Difference From Average
01-06-92	0.602	-0.33%
05-06-93	0.607	+0.50%
01-06-95	0.603	-0.17%
	0.604 (Average)	

In this case, the operator would be exempt from the requirement for further gas density updates at Meter A as three consecutive density updates fall within ± 1 per cent of the average of the three densities.

EXAMPLE 2.2:

Consider an 8-well pool producing gas under this configuration.

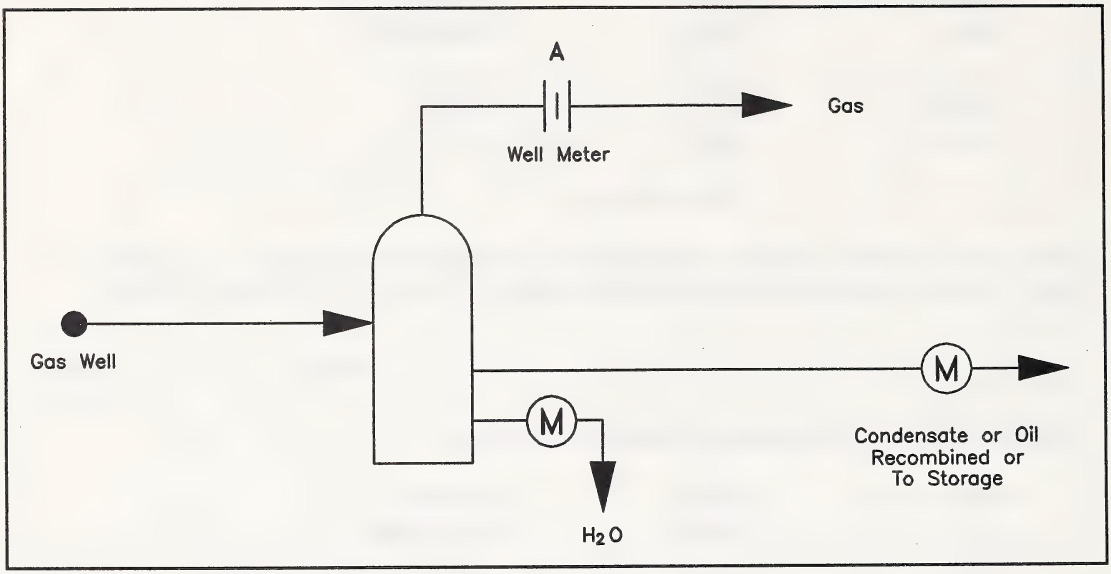
Well	Relative Density	Difference From Average
11-14	0.602	-0.99%
10-16	0.610	+0.33%
10-21	0.602	-0.99%
9-27	0.616	+1.32%
11-30	0.608	0.00%
6-31	0.616	+1.32%
11-32	0.606	-0.33%
11-16	0.604	-0.66%
	0.608 (Average)	

In this case, it would be acceptable to use the average density of 0.608 for the orifice calculation in all well meters as all densities are within ± 2 per cent of the average of the well densities. The average must then be updated every 2 years using well densities from at least four wells from the pool provided the four well densities are within ± 2 per cent of the average of the updated densities. When this criterion is not met, requirements would revert to each well every 2 years.

Permanent exemption on a pool basis would be available where the updated average densities meet the criterion of note 1. Where practical, the Board would expect the same wells be used to arrive at the average densities used in pursuit of this exemption.

Where all wells flow exclusively through a group meter, it would be acceptable to use the group meter density, in place of a calculated average, in the above calculations.

Figure 3 - Gas Well Installation (Produces Oil or Condensate)



Note: Other configurations may apply

For this configuration, the frequency of density updates will be determined by the gas rate through Meter A. Where the rate through Meter A exceeds 16.9 10^3 m^3/d (~ 600 mcfd) the minimum frequency is one density update per year. Where the monthly average rate is below this value, updating the density at least once every 2 years would be appropriate.

Notes

2. An average density for all wells producing to a common gathering system or facility **from a common pool** can be used where the density of all common-pool wells are within 2 per cent of the average density of those wells. Gas densities must initially be obtained for all the common-pool wells to arrive at the average density. Subsequent density measurements can be made on 25 per cent or at least four wells from the pool (whichever is greater) at the frequency stated in the guide, provided the relative density variance remains within the 2 per cent limit of these wells (see Example 3). Should the variance exceed this limit, well densities must be determined for each measurement point.

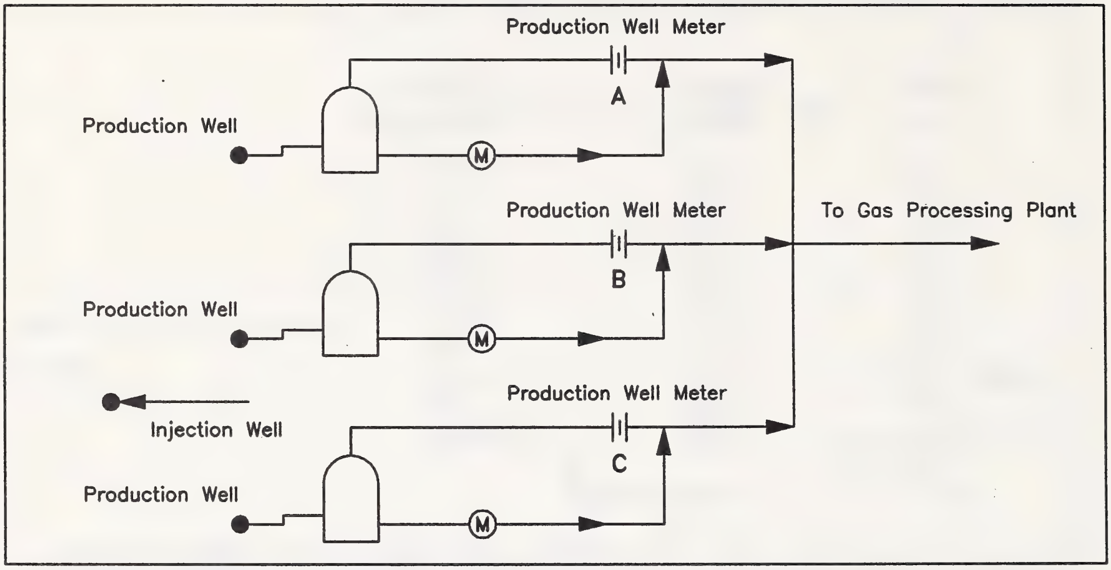
EXAMPLE 3:

Consider a 10-well pool producing gas under this configuration.

Well	Relative Density	Difference From Average
11-14	0.725	-0.67%
10-16	0.742	+1.66%
10-21	0.718	-1.63%
9-27	0.740	+1.38%
11-30	0.742	+1.66%
6-31	0.730	+0.01%
11-32	0.719	-1.49%
11-16	0.731	+0.15%
10-28	0.720	-1.36%
11-31	0.732	+0.29%
	0.7299 (Average)	

In this case, it would be acceptable to use the average pool density of 0.7299 (0.730) for all wells within the pool as the individual well densities are all within ± 2 per cent of the average of the individual well densities. The average must then be updated annually (or every 2 years if well flow rates are less than or equal to 16.9 10^3 m^3/d) provided the four updated well densities are within ± 2 per cent of the average of the updated densities. Where this criterion is not met, requirements would revert to well density updates on a 1-year or 2-year basis, depending on flow rates.

Figure 4 — Gas Cycling System



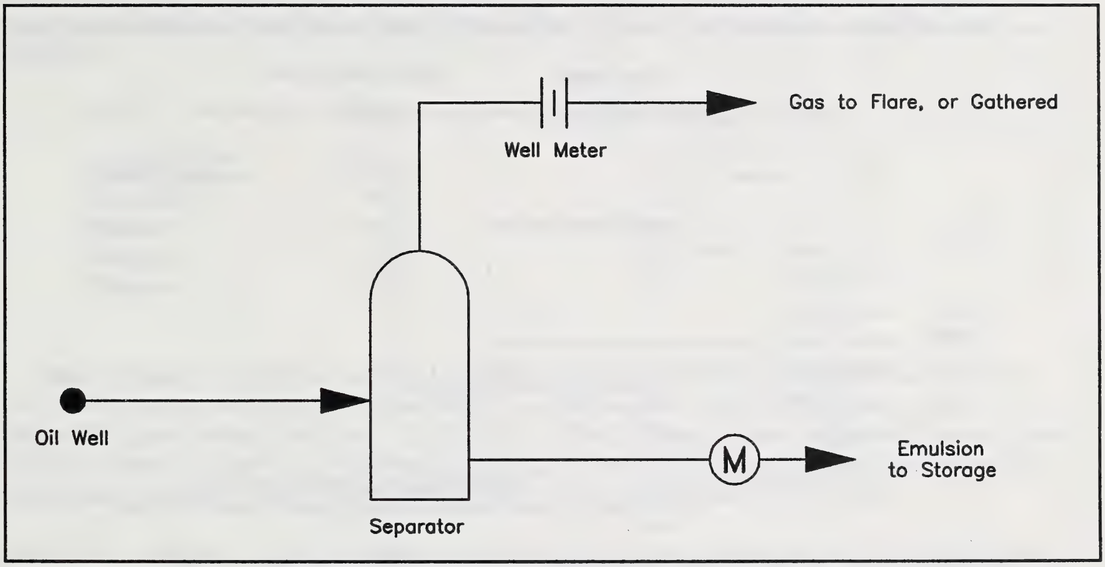
Note: Other configurations may apply

In this configuration, densities should be updated at each well meter (Meters A, B, and C) every 6 months after breakthrough at each well. Prior to breakthrough the densities at each well meter are to be updated as for a gas well producing condensate (see Figure 3).

EXAMPLE 4:

After 6 months of cycling, dry gas has broken through to well A; wells B and C show no signs of breakthrough. Gas densities are to be updated every 6 months at Meter A, and every year (assuming high-rate production) at Meters B, and C, until such time as breakthrough is evident at these wells.

Figure 5 — Single-Well Oil Battery



Note: Other configurations may apply

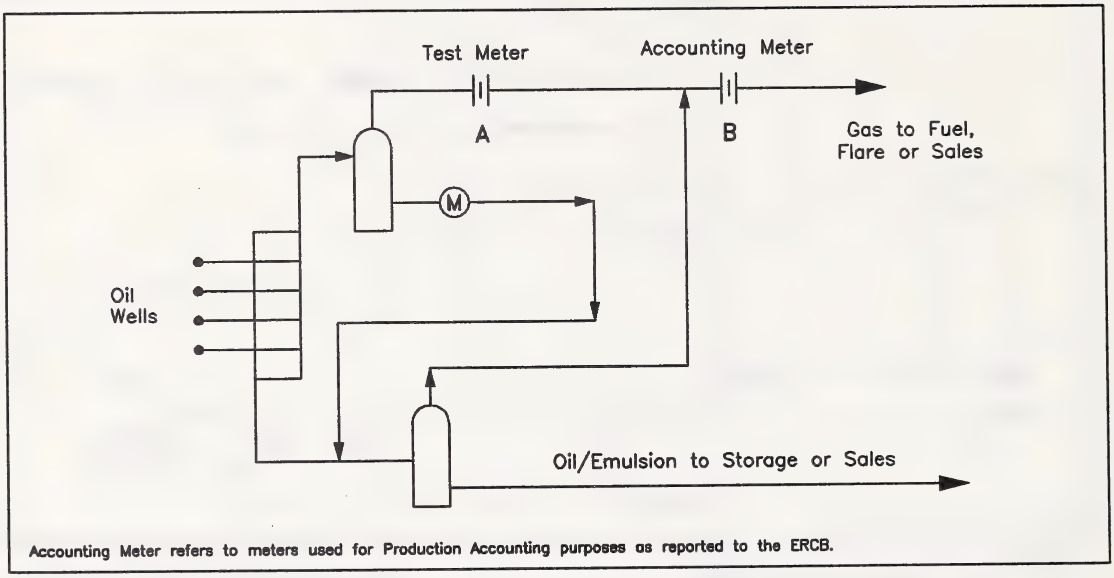
Conventional Oil Production

Where all solution gas (net of lease fuel) is flared, an initial representative gas density determination is required within the first 6 months of production, after which no subsequent updates are required provided the gas continues to be flared. Where gas from a single-well oil battery is conserved, gas density updates are required as for a proration battery (see Figure 6).

Crude Bitumen Production

Crude bitumen production at a single-well battery typically occurs directly to a production tank without separator or well meter. Subsequently, gas-oil ratio testing is performed using a positive displacement meter on the tank, or less frequently by separator and orifice meter. Where an orifice meter is used, an initial representative gas density shall be determined within the first 6 months of production with no subsequent updates required.

Figure 6 — Multi-well Oil Proration Battery



Accounting Meter refers to meters used for Production Accounting purposes as reported to the ERCB.

Note: Other configurations may apply

Primary/Water Flood (see Example 5.1)

In this configuration gas densities are to be updated at the test meter (Meter A) every 2 years, or annually where test gas rates exceed 16.9 10^3 m^3/d (~ 600 mcfd). It is acceptable to use the gas density from a single representative well as a pool density to represent all wells within that pool.

The gas density at Meter B should be updated annually, or every 2 years where the total rate through the meter is less than or equal to 16.9 10^3 m^3/d.

Note: Where the total battery gas, net of lease fuel, is flared and gas conservation has been shown to be uneconomic, initial pool densities may be determined with no requirement for future updates at Meter A. Updates of the gas density at Meter B, at the 1-year or 2-year frequency as determined by the rate, would only be required where the gas through Meter B originates from multiple pools. Where the gas through Meter B originates from a single pool, no updates are required subsequent to the initial density determination.

Miscible Flood (see Example 5.2)

Prior to breakthrough, wells under miscible flood shall follow the gas density update requirements of proration batteries under primary or waterflood production. Densities at Meter A are to be updated every 6 months for each well after breakthrough at that well, whereas wells that have not experienced breakthrough may continue to use a pool density at Meter A. Gas densities at Meter B are to be updated every 6 months after breakthrough of any of the wells.

EXAMPLE 5.1:

Consider a 5-well proration battery with two wells producing from the Lanaway Mannville E Pool and three wells producing from the Lanaway Elkton A Pool. Battery gas production is gathered and conserved.

Pool	Well	Test Gas Rate (10^3 m^3/d)
Mannville E	10-14	4.2
Mannville E	10-16	6.8
Elkton A	10-21	18.0
Elkton A	9-27	12.0
Elkton A	10-30	6.5

A density should be established for the Mannville E Pool, as a minimum using either the 10-14 or 10-16 well, and updated every 2 years at Meter A as the maximum rate through Meter A for Mannville E pool wells is less than 16.9 10^3 m^3/d. A density should also be determined for the Elkton A Pool at Meter A, again as a minimum using either of the three wells, and updated annually as the maximum rate through Meter A for Elkton A pool wells is greater than 16.9 10^3 m^3/d.

The density at Meter B should be updated annually as the total rate though the meter would be in the order of 47.5 10^3 m^3/d. If the total was less than or equal to 16.9 10^3 m^3/d density updates could be conducted every 2 years. Where the gas through Meter B originates from a single pool, this density should serve as a quality-check of the pool density used at Meter A.

EXAMPLE 5.2:

Consider a 4-well miscible flood scheme.

Well	Test Gas Rate (10^3 m^3/d)
6-11	12.0
7-14	6.8
10-14	20.6 (after breakthrough)
11-14	12.3

Prior to breakthrough all wells produced at less than 16.9 10^3 m^3/d and gas densities at Meter A were updated using a representative well (i.e. pool density) every 2 years. After breakthrough of the 10-14 well, gas density updates are required for the 10-14 well at Meter A every 6 months while the remaining wells continue to use a pool density update every 2 years.

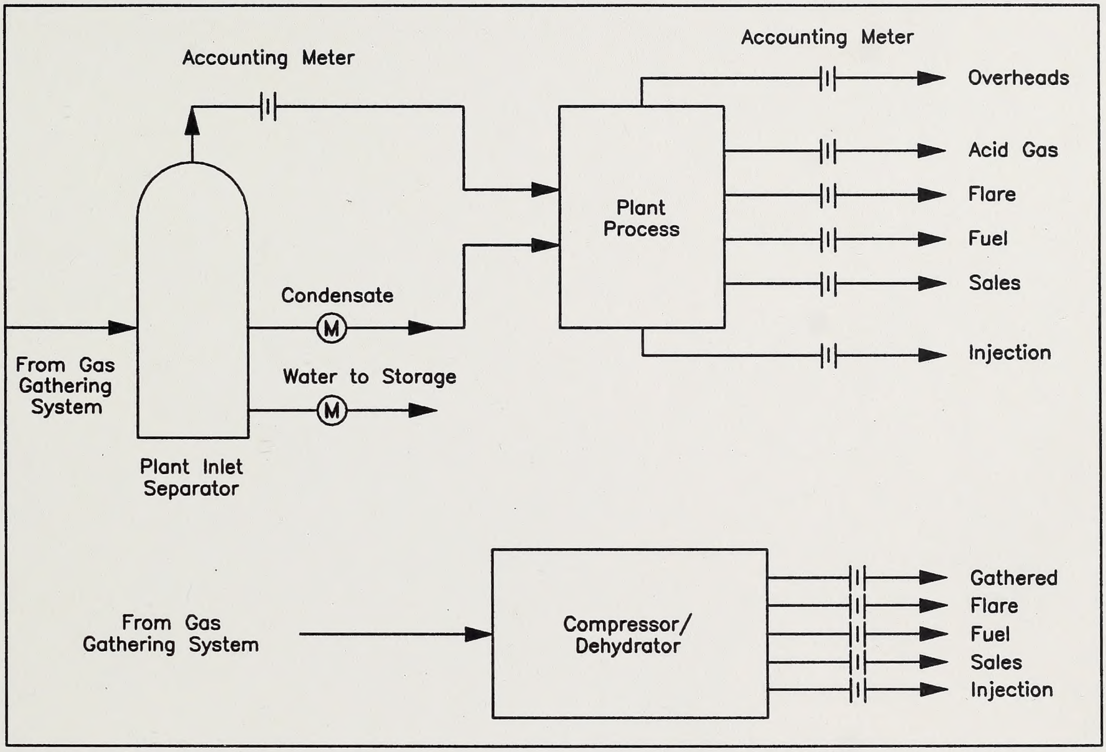
After breakthrough of the 10-14 well, the gas density at Meter B should be updated every 6 months.

Crude Bitumen — Multi-Well Facility (see Figure 6)

Consistent with the Alberta Recommended Practises (Volume 3) for Heavy Oil and Oil Sands Operations, gas produced in association with crude bitumen may be reported to the collection or emission point. Where associated gas is flowlined to a central facility or collection point, gas volumes can be reported on a facility basis without allocation back to the well level. The requirement to update gas densities therefore pertains only to the facility group or accounting meter, with no requirement for well-level density determinations.

In this configuration, Meter A may exist but is not required and the gas density at Meter B is to be updated every 2 years.

Figure 7 — Gas Facilities and Processing Plants



Note: Other configurations may apply

The minimum frequency for updating gas densities at all accounting meters within these facilities is once per year. More frequent updates would be appropriate when operating or other conditions change that can be expected to influence the composition, and therefore the density, of the gas through the meter. Such situations may include, but are not limited to, the following:

- addition of compression or refrigeration
- seasonal operation of compression or line heaters
- addition or deletion of wells, pools, or gathering systems

Note that where two or more measurement points occur on a common gas stream without variation in composition (eg. sales, fuel , and injection gases), it would be appropriate to apply a single gas density determination to all meters on the common stream.

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